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TO: ODW Professional Staff

THROUGH: Gerald W. Peaks, P.E., Acting Director
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SUBJECT: Emergency Response – Waterworks Guide for Contamination Threats to
Water Supplies

The Office of Drinking Water is exercising its discretion, under the Freedom of Information Act, to withhold this information pursuant to, §§ 2.2-3705.A., subparagraphs 57 and 69.

Purpose

The threat of intentional contamination of a waterworks and how to react initially is certainly daunting. The large waterworks should be revising their emergency response plans to include this possibility. Medium and small waterworks have up until June 30, 2004, and December 31, 2004, respectively to do so and may not have yet considered how best to prepare a response plan. Little guidance has been available to the waterworks to assist them in their planning.

Therefore, it is conceivable that waterworks representatives could ask our professional staff how best to characterize an incident site in order to sample for a suspected contaminant, etc. To be able to assist if such an inquiry occurred, this working memo relates the latest sampling guidance from EPA. More concrete guidance is expected over the next several months.

Background

The Office of Drinking Water (ODW), as well as the United States Environmental Protection Agency (EPA), believes that an intentional contamination event to a waterworks is possible. Potentially, a few contaminants can produce widespread death and/or illness in the population served by a waterworks. The most dangerous being purified biowarfare agents, including some biotoxins, and a few highly toxic chemicals that remain stable in water. There is a larger group

of contaminants of several dozen toxic chemicals and a few radionuclides that could cause localized death or illness in a segment of the population. Although they would not cause death and illness, there are hundreds of contaminants that could disrupt service and, more importantly, undermine consumer confidence and the economy. There are documented incidents from around the world in which the waterworks or a portion of a waterworks was the target of intentional contamination.

An actual or threatened water contamination event is a special concern to waterworks and the Virginia Department of Health (VDH) because of potential consequences including:

- Morbidity and mortality in the public,
- Loss of public confidence in the public water supply,
- Spread of fear (perhaps similar to the anthrax in the mail scare since both are delivered to where the public lives, goes to school, and works),
- Disruption of waterworks operations,
- Damage to the water infrastructure, and
- Costs of response activities, restoration, and recovery.

The contamination site can be rather well defined, e.g., a single building or storage tank or extend to an entire distribution system in the case of a nonspecific, but credible threat. However, determining the probability of a contamination event is difficult because good intelligence is lacking.

One of the daunting tasks in planning for and responding to a contamination threat to a waterworks is collecting samples from an incident site — especially early in the contamination management process. This requires field safety screening to protect personnel on the ground and written emergency response procedures on how samples are to be collected. If the site is characterized as anything other than a LOW hazard, a HAZMAT team should be called upon to continue the site characterization. This working memo will address the highlights of a protocol that addresses the above concerns. Additionally, since the site may become a crime scene, further complications arise in both preserving the crime scene, maintaining the chain of custody on samples, and taking additional samples that can be used in future criminal proceedings. The ODW role, at this time, is limited to advising of the above concerns and if needed, assisting where possible with the sampling activities such as delivering the 10-L carboys (stored at each field office) to the waterworks.

Site Characterization

Characterization of the incident site consists of site investigation and field safety screening. Sampling activities may include rapid field testing of water and sample collection, preservation, and shipment. Basically, there are two stages to site characterization. The first phase, as with most response activities, is planning. Typically, the water utility emergency manager (WUEM)

coordinates planning activities. The site characterization and sampling procedure developed by the WUEM should identify, as a minimum: pre-entry activities, sampling, exiting the site, and transporting the samples to the supporting laboratory. That planning should produce two templates from which to develop a site characterization and sampling plan. The first template addresses the site characterization plan and the second template addresses the initial sampling plan. To record actions taken, a form to document pre-site characterization events also needs to be developed during this planning stage.

A site characterization team implements the second phase. Depending on the incident and contaminant, outside agencies that may be involved include: the water utility, first responders (fire and police departments), HAZMAT responders, federal law enforcement (FBI and EPA's Criminal Investigation Division or CID), National Guard Civil Support Teams, and state/federal environmental response teams.

To facilitate the development of a site characterization and initial sampling plan, the incident command (or WUEC) will evaluate existing information. Information that may be available could be telephone threat, unusual online monitoring results, intruders detected on security videos or by other detectors (seismic, microwaves, motion), and witness accounts.

Initially, it may be possible to only characterize the site as a low or high hazard. A low hazard has no obvious signs of chemical, biological, and radiological contaminants present either in the air or on surfaces. High hazards are:

- Chemical. High hazard is when the presence of highly toxic chemicals (chemical warfare agents or biotoxins) or highly volatile industrial chemicals are tentatively identified at the site or in the water. The potential risk of exposure is through dermal or inhalational routes.
- Biological. High hazard is when the presence of pathogens are tentatively identified at the site. The potential risk of exposure is through dermal or inhalational routes.
- Radiological. High hazard is when the presence of radiological isotopes or emitters are tentatively identified at the site or in the water.

If there is an obvious indication of a HIGH hazard is present, then HAZMAT teams should conduct site characterization.

One assumes that contaminants that may be present in the water are diluted and are confined to the water. Therefore, if toxic substances (such as cyanide, pesticides, pharmaceuticals, etc.) are detected, but are contained exclusively to the water, the site would NOT be characterized as a chemical hazard site (for sampling purposes) unless there is a potential for aerosolization. Utility personnel could then elect to collect samples. Similar to chemical hazards, a site would only be characterized as a biological hazard site if any pathogens that may be present were not

confined to the water. If testing or evidence indicated pathogens were likely to be aerosolized or present on surfaces with which team members could come into contact, then the site would be characterized as a biological hazard (HIGH).

Site Zone Establishment

The site characterization team should define incident site area. Once the perimeter or “cold zone” is identified, it needs to be secured. A staging area or “warm zone” is established at a location along the perimeter. It controls the entrance and egress of personnel into the hot zone and is located far outside of the protective action zone. It is also the location at which personnel leaving the hot zone are decontaminated. If there are indications that chemical, biological, or chemical hazards are present at the site, law enforcement and HAZMAT teams will form a protective action zone or “hot zone.”

Field Safety Screening

Field safety screening is done to detect environmental hazards that pose a threat to the site characterization team. As part of the screening process, members of the site characterization team look around the area for:

- Discarded personal protective equipment (PPE), other equipment, containers,
- Sick or dead animals, insects, vectors, vegetation,
- Unusual odors, and
- Discolored, oily, or foamy appearance of water.

Survey for elevated levels of radioactivity, and, dependent on available information and capabilities, for additional hazards:

- Chemical warfare agents (CWAs),
- Biological weapons, and
- Hazardous volatile chemicals

The site characterization team reports the results as quickly as possible to incident command or the WUEM.

Depending on the preliminary findings, incident command will decide whether or not to proceed with site characterization and inform the team of its decision. If the field screening indicates acute hazards, then utility personnel are withdrawn and HAZMAT or an EPA Hazardous Materials Response Team will collect the initial samples. If no acute hazards are detected, then one presumes that any contaminant(s) present are confined to the water at diluted concentrations. Utility personnel may collect the initial samples under low hazard conditions.

Utility team personnel may minimize risks to by following simple, but familiar safety practices used when handling other hazardous materials:

- Use available PPE
 - Goggles with half-face respirators or full face respirators,
 - Proper footwear (no open toe or heel) with disposable shoe covers,
 - Chemical resistant suit or lab coat, and
 - Disposable nitrile or polyethylene gloves
- Avoid dermal contact with the water,
- Pour water samples gently to minimize volatilization/aerosolization, and
- Minimize time that personnel are on site (hot zone).

Results of the field safety screening are documented on a field safety screening reporting form. This is important for several reasons one being in case a contaminant was present it becomes paramount to know who was present on the team for medical evaluation.

The EPA recommends what components should be on hand for a field test kit. The recommended kit contains equipment necessary for both the field safety screening and the rapid testing of water. Some utilities already have access to this list.

Rapid Field Testing of Water

Rapid field testing of water provides additional information on which to evaluate the credibility of an event. Not only does it support the site hazard assessment process, it can determine if hazards tentatively identified in the water require special handling procedures. It can tentatively identify contaminants that need to be confirmed in the lab.

The core tests of rapid field testing are:

Radioactivity in water,
Cyanide,
Chlorine residual, and
pH.

If the site characterization team has additional capabilities, extended field testing may be possible. Extended testing, depending on the sophistication of the utility, could include:

- Acute toxicity screening (e.g., Microtox or Eclox),
- Field PCR,
- Immunoassay tests, and
- Field GC-MS.

Similar to the documentation of the field safety screening, record rapid field testing results. Remember that wastewater works also have laboratories with trained personnel and run more tests than the average waterworks.

Water Sample Collection

Regardless of rapid field test results, samples shall be collected. The decision to send the sample to a laboratory is based on the threat evaluation at the time of the sample collection. That information may be limited. If not sent, the sample should be preserved and properly stored (or archived) until the investigation is closed.

Similar to general sampling procedures, all sample containers must be labeled. Different procedures to follow may include:

- Wiping the outside of each sealed container with a mild bleach solution/antiseptic wipe,
- Using appropriate chain of custody procedures,
- Collecting duplicate samples for law enforcement, and
- Collecting quality control samples (duplicates, field blanks, field matrix spikes), as required.

Chemical hazard. If the site has been characterized as a chemical hazard, then diluting the samples for chemical analyses may reduce the hazards of shipping and analysis. For chemical contaminants already present in water, a 1/1,000 or 1/100 dilution can be made. For concentrated material, make a 1/10,000 dilution. If diluting the sample to be sent to the laboratory, archive a large, nondiluted sample. It is recommended to use 10-L carboys.

Microbiological hazard. New sample collection procedures, using a broad screen methodology, are being developed at the federal level. Until the time that the new procedures are available, sample collection for pathogens will rely on existing protocols for sample collection and analysis. That being the collection of samples (with appropriate dechlorination), but with much larger volumes than normally collected. Following sample collection, team personnel exits the site and, if deemed appropriate, are decontaminated.

New microbiological sampling procedures will include concentrating the samples to increase method sensitivity using a ultrafiltration device (commercially about \$800). A 100-liter sample is concentrated to 250 mL through cross-flow ultrafiltration. The accumulated material is removed and collected from the membrane by either mechanical or chemical means. Then the concentrate is separated into aliquots for:

- Field testing,
- Polymerase chain reaction (PCR) analysis, and
- Culture analysis.

The ultrafiltration technique, still under development, involves tangential flow across disposable, hollow-fiber ultrafiltration cartridges. It uses a size exclusion process in which microbes and biotoxins larger than the pores are retained. The sample concentrate or “retentate” is recovered by backflushing the hollow fiber cartridge.

Sample Shipment

If the threat is deemed sufficiently credible, then the sample should be packed and shipped in accordance with EPA guidance. If the decision is made not to send samples to a supporting laboratory, then the samples need to be archived until the investigation is closed.

Existing Laboratory Infrastructure

The analytical approach used is based on the existing laboratory structure in the US. The approaches described below may be revised if an Environmental Laboratory Response Network is developed in the future.

Chemistry laboratories. These include standard and specialized chemistry labs within federal, state, local government, utility, commercial, and academic sectors. For security purposes, four categories would be used:

- Environmental chemistry (water quality) laboratories. This is the largest group of labs. They include EPA, state, utility, and commercial laboratories. Typically, these labs are certified for analysis of parameters regulated under the Safe Drinking Water Act and Clean Water Act. If a lab does not routinely analyze a particular analyte, it may not have the associated method up and running for immediate analysis.
- Radiochemistry laboratories. Labs specifically equipped to analyze for a range of radionuclides should perform analyses. These include EPA, Department of Energy, state, and commercial radiological laboratories. The Federal Emergency Management Agency’s Federal Radiological Management Center can provide rapid response teams for radiological incidents.
- Biotoxin laboratories. There are currently few labs set up specifically for biotoxin analyses. Most that are focus on marine biotoxins in tidal waters and seafood products. Some laboratory response network labs (discussed later) may have the capability to analyze select biotoxins in water if the proper sample preparation occurred. Methods include gas chromatography- mass spectrometry (GC-MS), HPLC, immunoassay, liquid chromatography- mass spectrometry (LC/MS). However, capabilities are not widespread and standards are not readily available.
- Chemical weapons laboratories. Chemical weapons are defined as those chemicals that the

Chemical Weapons Convention has placed on its Schedule 1. In the United States, only two laboratories are qualified and permitted to work with Schedule 1 chemical weapons. These are the US Army Edgewood laboratory and the Lawrence Livermore national Laboratory. Only a federal agency, such as the FBI, will have access to these laboratories.

Microbiological laboratories. Either a public health laboratory that is a member of the Laboratory Response Network (LRN) or an environmental microbiology lab will analyze for waterborne pathogens. Note that neither may be well suited to analyze for all biological contaminants of concern.

- LRN laboratories. The Centers for Disease Control (CDC), the Association of Public Health Laboratories, and the FBI developed the concept for a laboratory response network to deal with bioterrorism threats which included pathogens and some biotoxins. Only LRN labs, registered with the CDC, can analyze for “select agents” listed in the Bioterrorism Act of 2002. (Select pathogens include anthrax, botulism, plague, tularemia, brucellosis, and others. However, it should be emphasized, that many waterborne pathogens are NOT “select agents”). Therefore, confirmatory analysis for select pathogens must be performed through the Laboratory Response Network. However, at this time, most LRN labs are NOT equipped to process water samples that may contain these pathogens and biotoxins. Primarily, the labs lack the preparation methods and ability to concentrate samples.
- Environmental microbiology laboratories. Environmental micro labs are EPA, state, utility, and commercial labs that analyze for waterborne pathogens. Most routinely only analyze for indicators of fecal contamination (total coliform, fecal coliform, and *E. coli*). Although standard culture techniques exist for common waterborne pathogens, for example, *Vibrio cholerae* and *Salmonella typhi*, these labs do not perform these analyses on a recurring basis.

Analytical Approach for Unidentified Contaminants

Once the decision has been made to send samples to a laboratory, an analytical approach has to be developed for the specific threat or event. Often, this will be done with very limited information. Officials from various agencies, especially the lab, need to be involved in developing the analytical approach. This is because of the extreme difficulty associated with identifying unknowns. It is not an exact science so do not expect a conclusive identification of unknown contaminants.

Screening for unknown chemicals. The chemical screen integrates several analytical techniques in order to cover a broad range of chemical classes. The focus of the chemical analytical approach is 35 priority chemicals, biotoxins, and radionuclides. These were ranked highly after an initial prioritization of credible contaminants. The list of 35 contaminants remained classified by CDC and EPA. Many can still be found in open source documents. The chemical screening consists of a basic and expanded screen.

The basic screen uses standard methods for performing the basic screen, but does not provide complete coverage for all target analytes. For example, currently there are NO standardized methods for biotoxin analysis. The expanded screen uses comprehensive techniques for all priority and hundreds of nonpriority chemicals. These techniques may include nonstandardized, exploratory techniques, such as immunoassay and LC-MS assays for biotoxins. In both screening approaches, chemical contaminants are divided into three classes:

- Organic analyses. Organic analyses use the following techniques: gas chromatography (GC), liquid chromatography (LC), gas chromatography- mass spectrometry, and liquid chromatography- mass spectrometry.
- Inorganic analyses. Inorganic analyses use: classical, wet chemistry techniques, atomic absorption spectroscopy (AA), inductively coupled plasma emission spectroscopy (ICP), and ion chromatography (IC).
- Radiochemical analysis. Radiochemical analysis will look for types of radiation (gross, alpha, beta, and gamma) and specific radionuclides (strontium-90).

Screening for unknown biologicals. The microbiological screen recovers: viruses, bacteria, parasites, and some high molecular weight biotoxins. There are four steps to a microbiological screen— concentration and recovery, rapid field screening, presumptive testing, and confirmatory testing.

Until the ultrafiltration technique (under development) is approved, a stopgap protocol must be used. A 4-L finished water sample can be concentrated by membrane filtration. Multiple membranes can be plated on separate selective or enrichment media for bacterial analysis.

Once approved, the ultrafiltration technique will allow retentate to be divided to provide samples for: field testing (produces presumptive results), laboratory culture analysis at a LRN level A lab (produces presumptive results), and laboratory molecular analysis testing (produces presumptive results). Confirmation, using culture analysis and PCR techniques, will be performed at a higher level LRN laboratory.

Future Developments

In addition to the techniques under development, some new tools from EPA will become available. Although not in time to help large systems complete their emergency response plans due by December 31, 2003, rather detailed guidance on emergency response planning is expected in the near term. Other guidance under development or planned are contamination threat management, remediation and recovery, and a less detailed planning guide for smaller utilities.